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EMBRYOLOGY.[1]

Embryology of Sponges.[2]—Mons. Yves Delage in an interesting paper describes discoveries, the acceptance of which implies the overthrow of our present ideas of sponge morphology. The post-larval development of three silicious sponges, Spongilla, Esperella, Reniera and of a horny sporge, Aplysilla, was followed, and it was found that in the essential features of development all the forms agreed.

Larva.—The larva in all four sponges is a solid larva, the superficial layer of which is composed of slender ciliated cells. The inner one contains, except in Aplysilla, three distinct kinds of cells, each kind destined to form a particular part of the adult body. Just beneath or scattered between the basal parts of the superficial elements, is a discontinuous layer of rounded or irregular cells, which the author claims form the definitive epidermis, and which he, therefore calls epidermic cells. Internal to this layer is a mass composed of amœboid and " intermediary " cells, the former characterized as well by the nucleus as by the power of throwing out pseudopodia, while the latter are immobile cells of rather a negative nature. In the Aplysilla larva the two latter classes cannot be distinguished.

While in Spongilla the ciliated cells form a continuous covering for the larva, in the larvæ of the three other sporges they are absent over one of the poles, posterior in Esperella and Reniera, anterior in Aplysilla. Here the epidermic cells lie at the surface. (Against this interpretation of the cells covering the non-ciliated pole may be urged the observations of the reviewer on Esperella and Tedania, in which sponges it was found that the cells in question and the ciliated cells of the larva are differentiated portions of an external homogenous layer, representing the ectoderm of the embryo.[3])

The large cavity which, as is well known, occupies the anterior portion of the Spongilla larva has, according to the author, no morphological significance. It is only a magnified lacuna, such as is found here and there in the inner mass of all solid sponge larvæ, and disappears during metamorphosis. It is probably concerned in maintaining the equilibrium of the larva.

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[1] Edited by E. A. Andrews Baltimore Md: to whom contributions may be addressed.

[2] Embryogénie des Eponges. Yves Delage. Archives de Zoologie Expérimentale et Génerale. Année, 1892. No. 3.

[3] Notes on the Development of Some Sponges. Journal of Morphology. Vol. V, No. 3, 1891.

Metamorphosis.—It is commonly believed that the ciliated cells of the larva flatten and become the epidermis of the adult, but Delage finds that the former absorb their cilia, assume a rounded shape and migrate into the interior, their place being taken by the epidermic cells which fuse with one another so as to form a complete membrane. Only over the non-ciliated pole of the larva does this inter-change of cells fail to take place, for here the epidermic cells have all along been at the surface.

The ciliated cells that migrate into the interior are destined to become the collared cells of the flagellated chambers. The interval between their immigration and the formation of the chambers is marked by a curious association of these cells with the amœboids. The latter elements engulf, amœba-fashion, the former. Complete fusion takes place between the bodies of the amœboid and the absorbed cells, but the nuclei of the latter remain distinct, and range themselves round the larger nucleus of the amœboid. (Multinucleate cells, whether formed in this way or not, undoubtedly exist in the developing sponge. They were observed by Götte (1888) who regarded the smaller bodies contained in them and arranged round the larger central one, as deuto-plastic structures, which become nuclei. Moss (1890) regards the small peripheral bodies simply as deutoplastic structures. Wilson (1891) describes them as nuclei). In Spongilla all the ciliated are so absorbed. In the other sponges only a portion are so absorbed. The rest unite with one another and with the (now) multinucleate amœboids to form a syncitium. To form a flagellated chamber several multinucleate masses approach one another so as to surround a central space, the cavity of the future chamber. The nuclei of the absorbed (ciliated) cells arrange themselves round this cavity and cell bodies are differentiated about them, while the nucleus of the original amœboid cell, surrounded by protoplasm, escapes from the anlage of the chamber, and becomes one of the wandering cells of the adult mesoderm (the reviewer, l. c., has shown that chambers are sometimes formed by the fusion of multinucleate masses, but has also shown that chambers may be simultaneously formed by aggregations of amœboid or "formative" cells, which may or may not be multinucleate. The two processes are regarded as fundamentally the same. Such observations would seem to contradict the author's thesis that it is the immigrated ciliated cells which form the chambers). The remaining ciliated cells forming the syncytium, unite in a similar manner and build up flagellated chambers.

The chambers are thus formed independently of any central space. The canals are likewise formed independently of each other, as so many irregular spaces, which gradually become lined with an epithelium consisting of "intermediary" cells, the remaining "intermediary" cells becoming the stationary elements of the adult mesoderm. The union into a connected system, of chambers and canals, with the formation of pores and oscula complete the development.

The conclusions enunciated in this paper as to the origin of the canal epithelium and the collared cells of the chambers differ from those presented in the author's previous notes on sponge embryology (Comptes Rendus, 1890, 1891), though the account of the formation of the adult epidermis remains the same. On these points the paper is nearly in harmony with the recent contribution of Maas on the metamorphosis of Esperia (1892), though Maas derives both canal epithelium and collared cells from immigrated ciliated cells. The weight attaching to this harmony of observation on the development of Esperella, is however, lessened by the direct contradiction in the accounts, given by these two authors, of the Spongilla development. In the latter sponge, which according to Delage agrees with Esperella, Maas (1890) has described and figured in a most detailed way the transformation of the larval ciliated cells into the flattened definitive epidermis.

Germs Layers.—As the author points out, his discoveries make it extremely difficult to draw a comparison between the germ layers of the sponges and those of other Metazoa. The case of Sycandra he thinks already constituted a serious difficulty. In this he adopts the point of view of Balfour, and is accordingly perplexed to find granular cells, such as in other larvæ constitute the entoderm, here forming the adult epidermis, while the ciliated cells invaginate to form the epithelium of the paragastric cavity. But the difficulty reaches its height when he attempts to compare the larva of Spongilla with that of other animals. This larva is covered on the outside by cells, which eventually form the epithelium of the flagellated chambers. While the cells which will constitute the adult epidermis are in the larva situated in the interior, i. e. beneath the surface layer of ciliated cells. These facts place us in a dilemma. Accepting the ordinary views on the structure of the sponge body, we would call the epidermis of the adult, ectoderm, and the epithelium of the flagellated chambers, entoderm. Adopting this position, we reach on turning to the larva of Spongilla, the strange conclusion that the swimming larva is covered with a layer of entoderm, while the ectoderm is internal! If, discouraged at this result, we decide to regard the germ layers as occupying the same relative position in the Spongilla larva as in the larvæ of other Metozoa, and therefore call the superficial layer of ciliated cells ectoderm, and the inner mass of cells entoderm, we reach the equally strange conclusion that the adult epidermis is composed of entoderm, while the lining epithelium of the flagellated chambers is formed of ectoderm! The only way out of the dilemma is to regard the sponges as a phylum which has followed from the start a path of development distinct from that of Cœlenterates and other Metazoa. This being so, a comparison of layers is impossible.

H. V. Wilson.

Development of the Newt.—Edwin Oakes Jordan[3] presented for the Ph. D. degree at Clark University a study of the common newt *Diemyctylus viridescens* Raf., that contains a very clear account of the maturation of the ovum, fertilization, cleavage, and formation and fate of the blastopore in addition to many new facts in the breeding habits of this interesting amphibian.

The " yolk nuclei " are considered at some length and regarded as " having a real physiological significance, probably related to the construction of yolk." In this formation of yolk there is " nothing to indicate that the yolk spherules increase by division, everything on the contrary indicates that they arise from points of independant origin."

The nucleoli in the egg nucleus aré described in their formation and disintegration and the idea advanced that they may be but enlargments of the minute granules making up the chromatin threads. Regarding the nucleoli as of nutritive function, acting during the anabolic period of maturation, the author would suggest that they might be compared with the macronucleus of an infusorian.

In the formation of the polar bodies there is an accumulation of pigment at the pole of the spindle suggesting the presence of a centrosome, but none could be found. Much in the same way the entering sperm, in fertilization seems to exhibit an attractive influence over the pigment granules. Elsewhere, however in speaking of the gastrula, the author supposes that pigmentation of the cells is a mark of physiological activity; so that we are left in doubt as to how for an apparent attraction of pigment may be a new formation of it.

In the account of the process of fertilzation we learn that there is no fixed and predetermined point of entrance of sperm and moreover several may, in fact normally do, enter one ovum without in any way causing abnormal development.

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[3] Journal of Morphology. VIII. 1893.

The reader of this chapter will notice how easy it is to extend ones anthropomorphism even to unclei!

The noticeable fact brought out in studying the cleavage is that it is very irregular and variable in normal eggs. Even the third plane that we expect to find horizontal may be so only in a small part of its extent or, more often, quite vertical. These points will be considered in another paper by the author and Mr. Ecleshymer.

The long axis of the animal is found to develope at right angles to the first cleavage plane: not agreeing with what seems the rule in the frog. This first plane cuts the egg at right angles to its elongation, (it is elongated by pressure in the oviduct) and this invariable rule is, the author holds, the result of that pressure, the first spindle being able to place itself more readily in the one direction than in any other. He thus adopts, provisionally, a mechanical explanation of the determination of the first cleavage plane in the newts' eggs.

In the vexed subject of gastrulation the author's position is that invagination, to some extent, does actually occur. Epiboly can be actually seen in living eggs "the small cells roll down over the others (epibolic invagination), and at the same time the cells around the edge of the blastoderm turn in and dissappear from view (embolic invagination?)"

The blastoderm closes in first from all sides equally then, usually, more rapidly and equally from the right and left side, but sometimes from behind forward more rapidly, occasionally, perhaps, from before backword more rapidly.

A slit is thus formed, which at first opens into the archenteron along its whole length but soon closes, except its anterior end, the evanescent neuropore, and its posterior end the definitive anus.

The author restricts the term primitive streak to the liner fusion of the germ layers.

The conspicuous ectodermal furrow, "neural groove," is thus no part of the primitive streak: it may be merely a result of mechanical stresses.

The mesoblast is figured as presenting, in some cases, most marked lateral pouches at the anterior end of the embryo.

Amphioxus.—Prof. E. B. Wilson[4] has published a fully illustrated account of the most important experimental work upon the eggs of Amphioxus mentioned in the January NATURALIST.

Animal eggs show three chief types of cleavage the radial, the spiral and the bilateral. In Amphioxus individual eggs are found that conform to each of these types; other intermediate methods are also observed. All these normal modes of clecvage are figured and described with great clearness.

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[4] Journal of Morphology. VIII. August 1893.

Any attempt to draw a close comparison between the cleavage of Amphioxus and that of the Annelids must fail. The tempting pole cells that the text books have inherited from Hatschek's account cannot be found: "the pole cells of Amphioxus are a myth."

By the method of Driesch the cleavage cells may be isolated and the subsequent cleavage of these studied. Many important facts result of which but a few may be referred to here.

One of the first two cells, completely isolated, may cleave like an egg, form a blastula, gastrula and even larva of the one gill-slit stage, all perfect but of half the normal size. If the cell is not completely isolated from its fellow but merely displaced it will develope more or less separate from its fellow so that all sorts of twins or more or less completely doubled, embryos, blastulas, gastrulas and larvæ result. Here it is of great import to note that the first cleavage of the displaced cells determines the axial relations of the resulting double monsters. "*Even a slight displacement of blastomers in the two-celled stage causes a change in the form of cleavage, such that the blastomers of the half embryo cannot be identified individually with those of a normal embryo half. The normal embryo develops as a unit; if it be disturbed in the two celled stage, this unity is destroyed and two new units established.*"

Moreover it would seem that "the unity of the normal embryo is not caused by a mere juxtoposition of the cells," . . . . "this unity is not mechanical but physiological" . . . . "there must be a structural continuity from cell to cell that is the medium of coordination and that is broken by mechanical displacements of blastmeres."

Returning again to the actual observations. One of the first four cells when isolated may cleave like a whole egg, may form a perfect blastula, gastrula, larva of one fourth the normal size. If the cells of the four-cell stage are not completely isolated various double, triple and quadruple blastulas may arise.

The isolated cell of the eight-cell stage may cleave in a way much like a whole egg but not identical with it. Rarely a blastula may result, one of one eight the normal size.

The author then applies all these observations to the questions of regeneration and the Mosaic Theory of Development. He takes a somewhat middle or combination position between the views of Driesch and Hertwig on the one hand and of Roux and Weismann on the other.

Roux and Weismann hold that histological differentiation is due to *qualitative* divisions of the idioplasm in successive mitotic cell cleavages and that the embryo is thus a mosaic of self-determining cells: moreover they assume that each cell may also receive *quantitatively* some unmodified idioplasm that remains dormant till called into activity by injury, etc., when regeneration of lost parts is to be accomplished. All this Wilson rejects: retaining, however, a modified form of the mosaic theory, believing that this principal does come in after the earlier stages of cleavage and at very different periods in different animals (the differentiation is however a physiclogical one, there being no loss of nor unequal distribution of actual idioplosm in cell divisions).

That the ontogeny is determined by the character of the ovum at the first; these first phenomena determine the subsequent ones; the prospective value of a cell is a function of its position at first but in later stages becomes fixed by internal changes largely due to the action of the whole upon this cell, these are conceptions in which Wilson comes into closer agreement with Driesch and Hertwig.

Experimental Studies on Teleost Eggs.—Dr. T. H Morgan[5] claims some very important and valuable results from an application of the experimental method to the study of early stages in the embryology of the fish, Ctenolabrus, Serranus and Fundulus.

Awaiting the publication of an illustrated paper we can here note but a few of the chief facts presented in this preliminary communication.

If one of the first blastomeres is removed and destroyed the other may develope a normal embryo which is larger than half a normal embryo but not as large as an entire one.

If half or two-thirds of the yolk be removed from the egg the cleavage is modified and the blastoderm has a peculiar shape yet a normal embryo results.

When the blastodisc is compressed so that a flat plate of cells is formed by cleavage there yet results a normal embryo.

If the germ ring be cut upon one side the embryo continues to be formed and is normal. It can also be shown by markimg the membrane with carmine that the head is a fixed point, the elongation of the body being posterier to this. Hence it follows that the germ ring takes no important part in the formation of the embryo and the *concrescence* theory receives a very severe blow.

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[5] Anatomischer Anzeiger. VIII. 1893.

Formation of the Annelid Eye.—Our knowledge of the embryonic stages of the eyes of Annelids has been so scanty that the additions made by Ed. Beraneck[6] cannot be but welcome however little claim they may have to being exhaustive.

The author has studied the egg of the Alciopidæ, in the larva and adult and added to what had been previously made known by Kleinenberg and Greef. The eyes in this family of annelids, it will be remembered, rank amongst the most complex and perfect of visual organs and are far larger and more specialized than those of any other annelids. The structure is as follows; the optic vesicle is closed, a single layer of cells acting as cornea on the side next the thin epidermis and as retina elsewhere. Within the vesicle are the dioptric media: a spherical lens next the cornea, a very voluminous vitreus body filling up the large vesicle and subdivided into an outer part towards the retina and a major mass towards the lens, finally the rods that tip the retinal cells and line the vesicle except on the side of the cornea. It is important to note that the eye is a closed vesicle not a cup as has been claimed by Graber and denied by Graff and Carriēre. Moreover this vesicle is a single layer of cells, hence the retina is a single layer of cells, each having a long rod pointing towards the centre of the eye. In the adult there are no cells in the eye except those that form the walls of the vesicle: neither lens nor vitreous body presents any signs of cellular origin. The piginet of the retina is in the cells that bear the rods, at the end whence springs the rod.

It is thus obvious that this eye has no resemblance to the arthropod eye: as the author points out in detail.

The formation of the eye is made out from sections of larvæ. The earliest taken, 3 mm. long, living it will be remembered inside a Ctenophore, has already two large masses of cells separate from the ectoderm and crowded on either side of the few brain cells. These masses are the eyes as first observed. Each is a solid mass with numerous nuclei. Of these nuclei the author would distinguish three kinds—the small ones that form the future vesicle: a few large ones that form certain remarkable gland cells, and finally a single cell in each mass destined to form the beginning of the lens.

In a remarkable way this cell by degeneration forms a centre about which products formed by gland cells aggregate till a minute lens is seen surrounded by more liquid substance: the space so hollowed out in the eye is still surrouned by numerous cells that gradually specialize as the cornea and retina.

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[6] Revüe Suisse de Zoolögie. I. June 1893.

Very early some of these retinal cells form a rod at the free end and afterward isolated grains of pigment appear in these cells, near the rod end. Meantime the few large gland cells, in the retina, instead of forming rods form a secretion poured out between the lens and the retina. The lens grows enormously, has no longer any trace of its cell origin, and is believed to increase, in some way, by aid of the glandular secretion.

The remarkable gland cells that are mentioned above as occuring even in the youngest larva studied may be found in the adult. They have the important function of secreting the vitreous body.

Each eye has one of these peculiar glands (they are not to be compared with minute gland cells seen in the retina) lying outside the wall of the retina though in its origin one of the mass of cells that gave rise to the whole eye.

This gland is a large protoplasmic mass with two large nuclei and often numerous smaller nuclei and leads through the retina into the optic vesicle by a sort of duct or process.

One other point the author has elucidated is the so called ciliary body, which proves to be merely a part of the retina that developes in an isolated position at the edge of the cornea.

It is apparent that as this eye arises quite independently of the brain and, as far as the authors observations go, of the epidermis also little comfort is to be got from it for those who would reduce the Annelid eye to a simple epidermal thickening: they must fall back upon the statement that the ontogeny of this highly specialized eye in an apparently aberant group throws no light upon the phylogeny of the Annelid eye.